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TRUclean II - VORRP VOLUME REDUCTION RESEARCH AND DEVELOPMENT PROJECT (VORRP) UTILIZING THE TRUclean PROCESS

SEPTEMBER 2, 1986 - SEPTEMBER 30, 1987

AWC INCORPORATED
NUCLEAR SERVICES

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LAS VEGAS, NV 89103

SEPTEMBER 30, 1987

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TRUclean II - VORRP

VOLUME REDUCTION RESEARCH AND DEVELOPMENT PROJECT* (VORRP) UTILIZING THE TRUclean PROCESS

September 2, 1986 - September 30, 1987

Norman R. Sunderland, Ph.D., RRPT

AWC, Inc.
4335 West Tropicana
Las Vegas, Nevada

September 30, 1987

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Holmes & Narver, Inc.

H86S-13

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Figures

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ABSTRACT

This research was undertaken to determine if the AWC TRUclean* process could remove radioactive contamination from differing soil matrices which were submitted by participating sites from around the nation. The TRUclean process was proven to be effective in the removal of plutonium from coral derived soil, hence the interest in applying the process to other radioactive contaminants and soil types.

Soils from the Nevada Test Site (NTS); Rocky Flats Plant (RFP) in Colorado; FUSRAP site at Hazelwood, Missouri; Monsanto-Mound site in Ohio, and the Ft. Dix site in New Jersey were tested. The AWC, Inc. TRUclean process was able to effectively decontaminate soils and concentrate the contamination into a substantially smaller volume than the original soil.

The AWC TRUclean process is a proven alternative to the complete disposal of radioactively contaminated soils.

* Patent pending

INTRODUCTION

In June of 1985, AWC, Inc., a Las Vegas, Nevada business firm providing Health Physics services to the nuclear industry, submitted a proposal to the Field Command of the Defense Nuclear Agency (FCDNA) regarding a new and innovative process for the decontamination of soil. As a result of several meetings during which AWC, Inc. provided technical details of this new decontamination process, FCDNA initiated a contract to "provide a decontamination pilot plant and to develop and demonstrate a procedure for the removal of transuranic element contamination on Johnston Atoll." This pilot plant has become known as the TRUclean process (Sunderland, 1986).

The research and development decontamination pilot plant tests were conducted on Johnston Island (JI) during 1985 and 1986. The TRUclean process achieved levels of volume reduction and activity removal which were greater than had ever been achieved before. These tests demonstrated a somewhat greater than 90% volume reduction and activity removal from the coral derived soil. This was such a significant reduction that the Department of Energy (DOE) was prompted to consider the decontamination of various soils under DOE jurisdiction (DeLaney, 1986). If similar volume reduction and activity removal could be realized with the DOE soils, substantial savings would be gained, even when considering the reduced burial costs at the Nevada Test Site (NTS).

Subsequent to the Johnston Island tests, agreements between the Department of Defense, Field Command Defense Nuclear Agency (DoD, FCDNA) and the DOE allowed the equipment, instrumentation and process to be tested at the NTS with various types of soil matrices other than coral derived soil.

A volume reduction and research development contract was awarded to AWC, Inc. through Holmes & Narver by the DOE, and the pilot plant was then shipped

from Johnston Island to the NTS. The equipment arrived at the Area 25 E-MAD facility during the last week of August, 1986.

The equipment and instrumentation were unpacked, inventoried and moved to the Engine Transport Maintenance Building (TRUclean II facility) the second week in September, 1986 (Sunderland 1986).

The research conducted on Johnston Island had suggested various modifications to the existing equipment. These modifications were completed during the months of October and November. The research also indicated the need for additional equipment which could assure a supply of environmentally clean and radiologically free water. This equipment was specified, purchased and installed as an addition to the TRUclean process.

System testing and calibrations were conducted in the second half of December, 1986 and the first two weeks of January, 1987 using local "clean" soil.

A summary of the test soils received at the facility is tabulated below:

Source	Volume (cu. ft.)	Arrival Date
DOE NTS Area 11	300	December 11, 1986
Rocky Flats Plant	986	January 13, 1987
DOE FUSRAP (Hazelwood)	300	March 26, 1987
Monsanto-Mounds	128	April 13, 1987
DOE NTS Area 13	173	June 22, 1987
BOMARC Missile Site, NJ	173	July 23, 1987

Testing of the contaminated soils began January 14, 1987 and continued through September 1, 1987. Each of these soils and their radiological contaminants presented unique challenges which were met with success by the AWC, Inc. research staff.

METHODS and PROCEDURES

1. NTS Area 11 Soil

Plutonium safety tests and plutonium oxide dispersion experiments were conducted at the NTS in Area 11 during the 1950's. These tests and experiments left some of the area soil contaminated with small quantities of plutonium and americium (Orcutt, 1982).

Forty (40) drums of plutonium-239 contaminated soil were removed from Area 11 and delivered to the TRUclean II test facility during December, 1986 and January, 1987. The soil was typically sandy loam with some residual plant and animal matter and an average pH of 8.4. Approximately 75% of the radioactive contaminants were found in the fraction of the soil which had a density of 2.4 g/cc. The plutonium to americium ratio was reported as 5.69 to 1.

Thirty-two test runs were conducted to develop the optimum operating parameters for the TRUclean II system on the NTS soil. The first eleven tests were completed in January. The best transuranic activity removal for that period was 96 percent. The best volume reduction for that same period was 58.7 percent. Most of these tests were of short duration with a process test rate of one cubic meter per hour. The jig diaphram stroke, bed media and water supply were varied independently to enable a study of the individual effects.

Ten final tests were conducted during the month of March using a new pump which provided a greater supply of water. A 97 percent activity removal and a 92.4 percent volume reduction were obtained as a result of proper parameters with the increased supply of water.

2. Rocky Flats Plant Soil

A total of 132 drums of plutonium-239 contaminated soil were shipped from the Rocky Flats Plant (RFP) near Golden, Colorado and delivered to the TRUclean II test facility at the NTS on January 13th and 26th, 1987.

The soil was typically a very dark, fine-grained clay with residual organic matter, along with man made debris. Approximately 30% of the soil particles were less than 150 microns in size. The bulk density was 1.076 grams per cubic centimeter and the specific gravity was 2.77 grams per cubic centimeter. The plutonium to americium ratio was estimated to be approximately the same as the Johnston Island ratio (7.65:1).

Eighteen test runs were conducted to develop the optimum operating parameters for the TRUclean II system with this soil type. The first test run removed all but 0.05 pCi/g of activity and realized a volume reduction of slightly less than 70%. The soil matrix was received partially frozen, which caused material handling difficulties with the crusher, shaker screen, trash screen, and auger. The second and third test runs were discontinued due to these problems. It was necessary to dry, screen, and partially size the soil prior to proceeding with further tests of the RFP soil. During this period the intermediate transport system (auger) was replaced with a cleated conveyer. These challenges were met and overcome, then operational parameters were developed which enabled us to consistently remove greater than 90% of the incoming activity.

3. FUSRAP (Hazelwood) Soil

A total of 40 drums of radium-thorium contaminated soil were shipped from the Hazelwood, Missouri site and delivered to the Truclean II test facility in March, 1987.

The soil was typically fine grained but in a heavy clay laden matrix. The rate of deposition from suspension in untreated water was in excess of 180 minutes. Particle dynamics and the slow rate of deposition combined to present complex processing challenges which were met by system modifications and an increase in manual treatment of the soil.

Thirteen test runs were conducted to develop the optimum operating parameters for the TRUclean II system with this soil type. The first thirty hours of testing (Runs 1 through 4) involved the development of initial operational parameters, calibration of the detector system to radium and thorium isotopes and tests to determine the best methods of effluent and material handling.

During these initial tests the Hazelwood material, due to its clay matrix and moisture content, would roll up into clay balls which would blind the shaker screen, stop the crusher and build up behind the weir in the separator bed and promptly force water into the cleated conveyer. As a result, a technique was developed to air dry the matrix and crush the clay balls. This technique allowed the processing to continue with minimal interruptions.

The utilization of filtration techniques allowed the removal of particles from the liquid effluent. The filtration system removed particles down to and including 0.5 micron in size. Water sampling and analysis indicated that all system waters remained free of radium and thorium contaminants.

4. Monsanto-Mound Soil

The plutonium-238 contaminated soil which was shipped from Monsanto Research Corp.-Mound (MRC-Mound) in two wooden boxes, was manually transferred into eleven drums to facilitate handling within the system.

As the soil was placed in the feed conveyer hopper, it was necessary to prescreen each drum to remove organic and man-made debris which was larger than 5.08 cm (2 in.).

Samples were taken from each material pathway to determine the effectiveness of the process in removing plutonium-238 from this soil type.

Seven tests were conducted to develop the optimum operating parameters while fractionally classifying the soil matrix. The larger contaminants were concentrated in the bottom of the hutch and the submicron contaminants in the liquid effluent were concentrated in the filter press.

Three additional test runs (runs 8, 9, and 10,) were completed to simulate the recommended duplex processing. Duplex processing is multiple staging or rerunning the material to enhance reduction.

Operational parameters were developed which enabled removal of greater than 90 percent of the incoming activity from the soil and realizing a greater than 90 percent reduction of the contaminated soil volume.

5. NTS Area 13 Soil

Twenty-three drums of soil contaminated with plutonium-239 were removed from Area 13 of the Nevada Test Site.

The first 15 drums contained less than 2 pCi/g of plutonium and tests were discontinued after two runs. The volume reduction was at the 94 percent level and the activity removed was 99+ percent.

The last eight drums contained greater than 42,000 pCi/g of plutonium. Though this was, without exception, the highest level of contaminated material we had ever attempted to decontaminate, we were able to achieve a 90 percent reduction in activity with the TRUclean process.

6. BOMARC Missile Site

Twenty three (23) drums of plutonium-239 contaminated soil were shipped by AWC, Inc. to the TRUclean II facility. These drums arrived on July 22, 1987.

Testing and processing began on August 11, 1987. Moisture, organic material (roots, stems, plant parts) and asphalt created handling and processing challenges.

Thirteen test runs were conducted on this material. The test data and laboratory analyses indicated that the asphalt caused considerable variance in the sample data. High purity germanium (HpGe) detector measurements were conducted to obtain a third data point for several of the runs. Good correlation existed between the HpGe and the system measurements.

The developed parameters and duplex processing will yield volume reduction and activity removal in the 90 percent range.

RESULTS and CONCLUSIONS

Final analyses confirm that radioactive contaminants can be removed from various soil media by the AWC TRUclean process and that those contaminants can be removed to such low residual levels that the soils could be released for "unrestricted" use.

Figures 1 through 6 illustrate the operational effectiveness of the TRUclean process for each soil type tested at the DOE's Nevada Test Site.

Operational parameters were developed which provided the means for drastically reducing the volume of contaminated material. Ninety (90) percent or greater of the soil volume can now be considered "clean" and ready for beneficial use. The radioactive concentrate would then reside in 10 percent or less of the original volume. This small amount of concentrate can easily be disposed of at an appropriate disposal site.

Preconditioning of some soils may be required. Preconditioning may consist of maceration, drying, removal of organics such as roots, stems and other plant or animal parts, and removal of material with any one dimensional measurement greater than 5.08 cm. (2 in.). Pretreatment of the soil could reduce the number and frequency of process stoppages and provide a continuous flow of feed material to the process.

Some materials are more difficult to process than others however, to date, we have been able to successfully process every soil type which has been provided. The degree of success depends upon the overall condition and characteristics of each soil type being processed.

The pilot plant is designed to have a maximum throughput of 1.5 cubic yards per hour and an optimum throughput of approximately 0.75 cubic

yards per hour. Production plants can be specified, designed and produced to provide from ten to thirty cubic yards per hour throughput. These plants could be self-contained, stationary or mobile and operate in the same efficiency range as the pilot plant.

Operational data from the research on each soil type is included as Figures 1-6. Details of the processing are available in each published interim report (Sunderland, 1987).

NTS

AREA 11

OPERATIONAL RESULTS

Run Number	Percent Activity Removal	Percent Volume Reduction	Feed Activity pCi/g	Discharge Activity pCi/g
1	86.82	36.66	102.28	13.48
2	85.13	58.74	96.77	14.39
3	82.52	37.90	114.90	20.09
4	73.34	36.78	100.09	26.68
5	83.93	23.52	74.34	11.95
6	94.52	23.03	98.80	5.41
7	82.48	27.80	85.78	15.03
8	88.82	26.67	65.37	7.31
9	94.26	31.13	42.52	2.44
10	96.05	45.45	74.62	2.95
11	91.80	36.17	70.39	5.77
12	83.66	26.85	118.64	19.38
13	79.48	25.63	166.21	34.11
14	84.79	28.19	119.19	18.13
15	64.71	64.20	23.38	8.25
16	77.61	60.12	31.62	7.08
17	86.27	61.02	30.81	4.23
18	82.83	52.30	25.45	4.37
19	88.82	62.10	11.81	1.32
20	90.61	62.10	12.88	1.21
21	90.95	78.85	11.60	1.05
22	91.00	45.27	115.77	10.42
23	94.59	36.18	90.91	4.92
24	95.76	55.31	101.68	4.31
25	94.87	56.99	111.16	5.70
26	95.00	58.10	108.44	5.42
27	92.87	62.24	57.82	4.12
28	93.61	64.60	69.82	4.46
29	66.99	66.12	82.42	27.21
30	97.05	62.55	122.03	3.60
31	82.40	92.49	11.41	2.01
32	78.80	89.49	5.33	1.13

Figure 1

ROCKY FLATS PLANT

OPERATIONAL RESULTS

Run* Number	Percent Activity Removed	Percent Volume Reduction	Feed Activity pCi/g	Discharge Activity pCi/g
1	98.88	64.30	4.47	0.05
2	99.12	68.76	5.70	0.05
4	95.99	77.06	28.42	1.14
5	93.95	78.59	27.92	1.69
7	96.50	96.56	29.72	1.04
9	99.47	94.03	39.65	0.21
11	92.85	78.25	23.35	1.67
12	96.18	78.02	19.09	0.73
13	91.01	88.33	30.25	2.72
14	43.84	73.41	51.67	29.02
15	63.44	78.44	30.83	11.27
16	34.43	81.02	25.73	16.87
17	74.53	71.00	68.39	17.42
18	62.07	75.46	69.05	26.19

*Runs 3, 6, 8 and 10 were aborted.

Figure 2

FUSRAP (Hazelwood)

OPERATIONAL RESULTS

Run Number*	Percent Activity Removed	Percent Volume Reduction	Feed Activity pCi/g	Discharge Activity pCi/g	
				Radium	Thorium
5	82.86	99.43	10.50	1.80	ND
6	90.48	99.45	14.70	1.40	ND
7	68.00	99.32	5.00	1.60	ND
8	UK	98.38	**	1.40	7.50
9	UK	98.89	**	ND	ND
10	100.00	99.34	2.90	ND	ND
11	72.94	98.99	8.50	1.20	1.10
12	67.90	99.06	8.10	1.40	1.20
13	53.23	99.42	6.20	1.70	1.20

* Data from the first four runs were for parameter development only and were disregarded due to multiple material handling problems.

** The analytical results from runs 8 and 9 did not indicate the presence of radium or thorium isotopes. The investigation of analytical anomolies from an independent laboratory was not possible during the alloted time.

ND Not detectable

UK Unknown

Figure 3

NTS

AREA 13

OPERATIONAL RESULTS

Run Number	Percent Activity Removal	Percent Volume Reduction	Feed Activity pCi/g	Discharge Activity pCi/g
1	96.00	100.00	1.65	<0.074
2	99.00+	100.00	2.00	ND*
3	78.59	65.00	42,700.00	9145.00
4	89.14	65.00	35,800.00	3888.00

* Not Detectable

Figure 5

MONSANTO-MOUND

OPERATIONAL RESULTS

Run Number	Percent* Activity Removal	Percent** Volume Reduction	Feed Activity*** pCi/g	Discharge Activity*** pCi/g
1	89.41	50.20	46.80	9.90
2	58.42	63.35	100.60	68.00
3	86.14	68.17	174.20	34.00
4	86.66	61.18	188.90	42.00
5	75.35	71.72	64.40	23.00
6	83.51	46.70	58.70	21.00
7	90.52	46.70	96.90	20.00
8	73.15	73.58	32.70	12.00
9	80.18	75.00	23.10	6.10
10	84.13	91.00	32.60	6.80

* Derived from the comparison of the total feed & discharge activity for each run.

** Derived from the comparison of the total feed & discharge volume for each run.

*** Average activity for each run from laboratory aliquots.

Figure 4

NTS

AREA 13

OPERATIONAL RESULTS

Run Number	Percent Activity Removal	Percent Volume Reduction	Feed Activity pCi/g	Discharge Activity pCi/g
1	96.00	100.00	1.65	<0.074
2	99.00+	100.00	2.00	ND*
3	78.59	65.00	42,700.00	9145.00
4	89.14	65.00	35,800.00	3888.00

* Not Detectable

Figure 5

BOMARC SOIL

OPERATIONAL RESULTS

Run Number	Percent Activity Removed	Percent Volume Reduction	Feed Activity pCi/g*	Discharge Activity pCi/g**
1	99.00	55.90	2800	28
2	97.67	50.00	3770	88
3	97.54	55.18	2600	61
4	76.98	59.94	126	29
5	96.83	49.91	473	15
6	93.75	50.05	480	30
7	95.12	55.53	860	42
8	91.43	64.20	210	18
9	56.43	57.00	140	61
10	99.97	66.71	720	2
11	82.36	79.97	62	11
12	99.97	75.12	730	2
13	96.56	85.98	29	1

* pCi/g of americium-241 from Laboratory Results

** pCi/g of americium-241 from NaI measurements

Figure 6

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JACOBS ENGINEERING GROUP, INC., ENVIRONMENTAL SYSTEMS DIVISION

MEMORANDUM

TO J Millard DATE June 8, 1988

FROM P A Miskimin Paul Miskimin

SUBJECT TRU Clean Process

The attached material briefly describes the results of tests performed on soils from the Hazelwood, Missouri FUSRAP site Primary radioactive contaminants in the test materials were radium and thorium The TRU Clean process was used to perform the soil decontamination, and achieved a 90% reduction in volume and activity

Considering that Hazelwood is one of the sites included in TES Work Assignment No 571, we would be seriously remiss if we did not amend the technology survey document we prepared for EPA to include the TRU Clean process

By copy of this memo, Bob Peel is advised of the possible usefulness of the TRU Clean process for UMTRA applications. Briefly, if the volume of mill tailings piles requiring stabilization and radon covers could be reduced by 90%, the associated costs and environmental impacts could be dramatically reduced

PAM/sjk

cc: D Truitt
D. Dubois
D Gonzales
R Peel
P Stassi

Paul, 6/9/88

Thanks for the memo. I CONTACTED AWC about two weeks ago about the possibility of using the TRU Clean Process at the Belfield and Bowman UMTRA sites I intend to propose a value engineering study for implementation at UMTRA Sites

Bob Peel

CC: D Dubois
D Truitt
J Millard